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MULTIPLE BLADDER
PARTIAL BODY OR FULL BODY SUPPORT MASSAGE SYSTEM
INCLUDING A METHOD OF CONTROL

FIELD OF THE INVENTION

This invention relates to vehicle or chair seating or bed support configurations comprised of inflatable expandable chambers or air cells for controlling the contour of the supporting inflatable cells to produce selective body or full body massage.

BACKGROUND OF THE INVENTION

Inflatable expandable chambers or air cells have been used in a variety of configurations to provide adjustments to the pressure in the inflatable air cells so as to produce a massage action on an occupant supported on the inflatable expandable chambers or air cells. This is especially important in automobiles where long periods of driving can cause pain and distraction or in other seating applications where individuals are sedentary for long periods of time.

Prior art seating systems including body massage are set-forth in USPNs 4,655,505; 4,981,131; 5,135,282; 5,587,933 wherein inflatable expandable chambers or air cells are provided to adjust the pressure to produce a massage action on an occupant of a support surface. In the '505 patent the only type of massage mentioned incorporates changes in the support pressure.

In the '282 patent a sequential control of the pressure in expandable chambers or cells pressure includes a sequential pressurization of each of the chambers or cells forming the back support for a supporting surface.

The expandable chambers are interconnected by valves that are responsive to pressure in the expandable chambers to cause one after another of the cells to be inflated and then deflated. The result is a broad wave front type of massage that requires transfer of pressure through all of the cells rather than flow of fluid to and from each cell. The requirement that pressure responsive valves direct

flow between each of the cells increases the time required for a full massage sequence.

In the '131 and '933 patents a massage control is provided to produce a pressure change at a given body part. There is no mention how a massage index might be utilized to produce a concentrated massage at more than one expandable chamber. The '131, furthermore, requires a range of movement in a single cell to cause the spine of the user to be moved or manipulated. Such action is more extreme than required for massage action.

While suitable for their intended purpose, the various known occupant support or vehicle seat systems with inflatable expandable chambers for contour shaping of a support such as on a vehicle seat surface do not provide for indexed expandable chamber pressure control. Furthermore, such systems do not disclose a support system having more than one expandable chamber operated to provide massage movement that includes a sequence of inflate and deflate of each of the respective chambers or cells so as to provide concentrated massage action while eliminating the problem of long massage cycle times as found in the '282 patent.

SUMMARY OF THE INVENTION

G2 A system of inflatable expandable chambers or air cells is constructed and installed in a seat or other like occupant support at locations which are strategic to the comfort of the user. The expandable chambers or air cells are connected to a pressure system including a pressure source such as a pump. The pump supplies pressurized fluid to a manifold and valve arrangement which simultaneously or sequentially, as desired, connects each cell to the pump to inflate each cell. The flow of fluid into and out of each of the expandable chambers is controlled by means of a system of supply valves and one or more exhaust or vent valves to produce massage movement that includes a sequence of inflate and deflate of each of the respective expandable chambers or cells so as to provide more concentrated massage.

Specifically, the massage of the present invention includes an inflate; a deflate and possibly an equalization of pressure between two cells (equilibration).

In the present invention inflate is defined as an increase in volume or pressure of fluid (including but not limited to air) in one of one or more expandable chambers. Such increase in volume or pressure is effected by opening a supply valve and closing a vent valve while energizing the pump(s) to move volumes of fluid either for a time or until a specified pressure is achieved. In most cases, the pump is connected to a manifold or common chamber and a supply valve is connected to each of the expandable chambers to control the flow of fluid the between the common manifold chamber and the other one or more expandable chambers.

Deflate in the present invention is defined as decreasing the volume or pressure of fluid (a fluid may include air but is not limited to air as the fluid medium) in one of the expandable chambers. Such deflation is effected, in one configuration, by closing a supply valve to the chamber and opening a vent valve to move volumes of fluid either for a time or until a particular pressure is achieved. Such deflation is effected, in another configuration, by opening the vent valve (controls the flow of fluid from the common chamber to the atmosphere) and the supply valve to the particular chamber (controls the flow of fluid between the common chamber and the other chambers).

Equilibrate is defined in the present invention as an exchange of fluid (including but not limited to air) between two or more of one or more expandable chambers. Such exchange of fluid is effected by closing the vent valve(s) of two or more chambers and opening supply valves to the same two or more chambers for a specified time. The fluid will flow from the higher-pressure chamber(s) to the lower pressure chamber(s) resulting in an equalization of pressure in all of the participating chambers. The resultant pressure will be less than the initial higher pressures and more than the initial lower pressures unless the pressures were equal to start with.

In one controller suitable for use in the present invention, a microcomputer's non-volatile memory is programmed with data representing a

desired massage type and level for the expandable chambers or cells. By sequentially activating individual supply valves, a pressure signal from a transducer can be generated for each cell. The pressure signals are received by the microcomputer and can be compared with the predetermined massage level data to generate a control signal which activates the pump or open and close the supply and exhaust valves. Additionally, in accordance with the present invention, expandable chambers forming the contouring elements of the seat back and seat bottom can have their pressure controlled by a timer to control the activation of the pump or opening and closing of the supply and exhaust valves to produce the desired massage affect.

One purpose of this invention is to provide a fluidly (in some cases pneumatically) controlled support surface for an occupant such as in a seating system or bed having an array of expandable chambers or cells. Each of such expandable chambers is connected to a source of pressurized fluid (air), and arranged in a manner to inflate in response to produce a massage movement that includes a sequence of inflate and deflate at each of the respective cells in accordance with a massage index for concentrating the massage action on an occupant.

An object of the invention is to provide a massage method for a occupant support surface wherein one or more of the expandable chambers or cells is connected through an exhaust valve that will be opened in accordance with a control signal to produce a massage movement including a separate deflate at each of the respective cells so as to provide more concentrated massage.

Furthermore, another object is to provide more than one expandable chamber that will provide an indexed massage in accordance with user selected massage types and preprogrammed inflation and deflation of individual expandable chambers by inflate and deflate steps including flow to and from each of a series of individual expandable chambers so as to produce a concentrated pulse type massage action.

A further object is to provide such a pulse type massage action by inflating each of the individual expandable chambers in a progression and thereafter

deflating each of the individual expandable chambers by reversing the progression.

One feature of the present invention is to provide the system of the preceding objects wherein the control sequence for the concentrated massage action is under a microcomputer control.

A still further feature is to include the expandable chambers as a seat back and seat bottom support including such occupant massage.

Another feature of the present invention is to provide a control system for such massage in the supporting surface of a occupant support including a microcomputer that is programmed to operate a manifold/valve system to automatically fill and deflate individual expandable chambers by fluid flow to and from each expandable chamber in a serial fashion so as to so as to provide more concentrated massage.

Still another feature of the present invention is to provide a microcomputer in the aforesaid systems in which the controller is programmed to operate multiple valves and a pump to conduct an initial inflate of the expandable chambers or cells to a gross pressure level with all of the valves initially open followed by continuous pressure reads and a sequential closure of each pressure zone formed by one or more cells as the pressure therein is compared by operation of the microcomputer to a desired target pressure and to provide a secondary adjustment of the desired target pressure.

A further object of the present invention is to provide a microcomputer control of the preceding object wherein the sequential control of the fluid volume flow to and from each expandable chamber or cell is either by a pressure pump inflation with open supply valves inflation or by an exhaust valve deflation.

Still another feature of the present invention is to provide a microcomputer in the aforesaid systems that conditions the system to open all the cells to atmosphere when a seat is not occupied and to inflate the seat back to a desired initialization pressure for occupant support.

Still another feature of the present invention is to provide a microcomputer in the aforesaid systems in which an initial occupant assessment is made and inputted to the microcomputer and utilized to establish a selected massage index in

a look-up table for use in a massage control operation of the system.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of an automotive seat showing one embodiment of the invention for locating pneumatic massage expandable chambers or in the back, seat and head rest positions of a vehicle seat structure.

Figure 2 is a view of a pressure supply system for the embodiment of Figure 1;

Figure 3 is a view of a programmable massage operating system for the embodiment of Figure 1;

Figure 4 is a view of another embodiment of a massage system for use with the method of the present invention; and

Figure 5 is a view of still another embodiment of a massage system for use with the method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A series of expandable chambers or bladder like air cells 1 are placed at strategic locations about the contour of an automotive seat 2 as shown in Figure 1. The expandable chamber or cell placement is selected to coincide with key pressure points on the body of an occupant of the seat.

In particular, a plurality of expandable chambers or cells 3a, 3b, 3c are positioned in the thoracic region while plural cells 4a, 4b, 4c are combined in the lumbar region. To further facilitate the adjustment of the seat, pairs of cells 5, 6, 7 and 8 are positioned at either side of the back and seat as well as the front and back of the thighs respectively. Each of these cells is in direct contact with the body to

provide the control system with information which may be related to the comfort of the user and in accordance with this invention to provide a desired massage action.

In addition to the pairs of cells that are provided to adjust the comfort of a user, in accordance with the present invention a plurality of expandable chambers 9 are formed in the head rest and a plurality of expandable chambers 10a, 10b, 10c are provided in the seat bottom.

The cells are connected to a pressure system including a source of pressurized fluid provided in part by a pump 12 through a manifold 14 as shown in Figure 2. The manifold 14 and pump 12 are controlled by a controller 16 responsive to pressure signal from a transducer 18. Alternatively, instantaneous data may be sensed by an array of force sensors as described in U.S. Patent No. 5,283,735 in the place of the transducer 18. In the latter instance the sequencing would remain the same, but it would be coordinated with a polling of the sensor array.

Each individual expandable chamber or cell is constructed of a suitable flexible material such as rubber, thermoplastic polyurethane coated fabric or any other material provided with a fluid tight connection to the manifold to provide a path for conducting fluid into and out of the cell. The cells may be connected individually to the manifold or jointly with other cells. Individual spaced parallel cells 3a-3c, 4a-4c, and 10a-10c, located for full body support and for full body massage if desired, are each connected to a single supply valve 26 controlled in a manner to provide a concentrated pulse or wave action massage to be described. The invention also contemplates use of a pressurizable mat in place thereof that includes segments that are pressure controlled to produce the massage action of the present invention.

The manifold 14 consists of a housing 20 enclosing a common chamber 22 constructed with multiple outlet ports 24 for connecting the common chamber 22 to the inlet/outlet tubes of each individual cell or regional group of cells. Each outlet port 24 is provided with an outlet or supply valve 26 to each expandable chamber (or group of expandable chambers if interconnected) for controlling the flow of fluid to and from each of the expandable chambers or cells. In this embodiment,

the sensor is a pressure sensing transducer 18 that is operatively connected in the manifold to sense the pressure in the common chamber 22 and generate a signal indicative thereof. Chamber 22 is also constructed with a single inlet port 28 which is connected to a feed tube 30 to receive pressurized fluid, in this case air, from pump 12. A supply valve 32 is provided in feed tube 30 to control the flow of pressurized fluid to the manifold. The manifold can be molded of a high strength plastic material or other suitable material. The plastic material arrangement can have many of its components integrally molded therein. It is preferred that it be as compact and lightweight as possible. However, the invention can be configured with other than lightweight components and other than with integral components. A common exhaust valve 34 is provided to selectively release pressure from the common manifold chamber 22 through venting port 36. The pressure in common chamber 22 can therefore be adjusted by either actuating pump 12 or exhaust valve 34.

In the embodiment of Figure 4, a pressure system is shown somewhat diagrammatically as including a controller 16' and a common manifold chamber 22' that is connected to a pressure source shown as a pump 12'. The controller 16' includes a valve drive 35' and a pump drive 12b' like those shown in Figure 3. The pressure system includes a supply valve 26' to each of the expandable chambers or air cells 3', 4', 10' with it being understood that the chambers 3', 4' and 10' can include three separate chambers as in the first embodiment. In this embodiment, exhaust is provided by a second pump 12a' connected to a second common manifold chamber 22a'. An exhaust valve 34' is connected to each of the expandable chambers and to the second common manifold chamber 22a'. In this embodiment, the inflate of each cell is the same as in the first embodiment. The deflate is produced when a valve 26' is closed to one of the expandable chambers when the exhaust valve 34' connected to the one of the expandable chambers is opened and the pump 12a' is energized to produce a rapid movement of fluid from the expandable chamber that is being exhausted. Such inflow and outflow patterns produces a direct and concentrated inflate and deflate at each of the respective expandable chambers in accordance with massage indexes to be described.

In the embodiment in Figure 5 a pressure system is shown somewhat diagrammatically in which a supply pump 12", valve drive 35" and pump drive 12b" like those in Figure 3 are connected during inflate through a common chamber or conduit 22" thence through supply valves 26" to each one of more than one expandable chambers 3", 4" and 5" with it being understood that the chambers 3", 4" and 10" can include three separate chambers as in the other embodiments. Deflate is produced when exhaust valves 34" are opened and valves 26" are closed so as to connect individual ones of the expandable chambers to a common exhaust conduit 22a" that is connected in turn to an exhaust pump 12a". In this embodiment the exhaust valves 34" are connected to a conduit 27" for fluid flow both to and from each of the expandable chambers.

Supply valves 26, 26', 26" and exhaust valves 34, 34', 34" are actuated by an electrical signal from a valve drive 35, 35', 35" and are designed for low power, low fluid resistant operation. More specifically each valve 26, 26', 26", 34, 34', 34", is an adaptation of highly efficient valves used in medical applications such as MEMS type or piezoelectric actuated valves. The bodies and valve seats of such designs are easily moldable with and can be integrated as lightweight components within the manifold body. Individual valve bodies can be designed for stacking assembly to form the manifold of this invention. In addition to a piezoelectric actuated valve other low energy actuated valves are contemplated by the present invention including but not limited to electrically pulsed reed valves; valves having an actuator configured of nickel titanium alloy such as Nitinol; magnetic inductive type valves or fluidic control valves so long as low energy consumption will operate the valve in on-off positions in which the flow from an inlet to outlet will satisfy the flow requirements of the pressure adjusted expandable chambers or in a given electropneumatic system for controlling a seating surface such as a seat, chair or bed to provide contouring, movement, support and/or comfort at a user interface. The importance of the use of such a valve arrangement in the present invention is that, in the past, pressure adjusted systems have utilized solenoid actuated valves to open and close an expandable chamber or to a pressure source for inflating the expandable chamber or to a relief path for deflating the expandable chamber or. In

such applications, the size of the control package is difficult to contain within the confines of a vehicle seat structure. Furthermore, power consumption is a problem since the major power consumers in the system combine power flow for operation of a motor driven pump and the power flow for operating the solenoids connected to the mechanical valving components. However, if desired, the supply valves 26, 26', 26" and exhaust valves 34, 34', 34" can be solenoid operated valves.

The active parts of the systems of this invention namely, the transducer 18, pumps 12, 12', 12", 12a' and 12a" as well as exhaust valve 34, 34', 34" and supply valves 26, 26', 26" are interconnected electrically to a controller 16, 16', 16" which controls the operation of the system. The controller 16 can be a commercially available microcomputer such as the PIC16C76 variant manufactured by Microchip. A microcomputer as used herein includes all subsystems and peripheral components as is well known to those skilled in the art. The controller 16 has access to non-volatile memory which has been programmed to provide a predetermined comfort standard such as the algorithm described in U.S. Patent No. 5,283,735.

A microcomputer's non-volatile memory is programmed with data representing a desired massage type and level for the expandable chambers or air cells. By sequentially activating individual manifold valves, a pressure signal from the transducer can be generated for each cell. The pressure signals are received by the microcomputer and can be compared with the predetermined massage level data to generate a control signal that activates the pump or opens the supply valves and/or exhaust valves. By varying the number and location of the cells the system becomes responsive to the localized pressures exerted on the body for a great variety of uses. Additionally, in accordance with the present invention, expandable chambers forming the contouring elements of the seat back and seat bottom have their pressure controlled by massage indexes that will produce a desired concentrated massage action. Such data can be compiled and coded for use with individual expandable chambers or regions of expandable chambers. Where base occupant support is included as set-forth in United States Patent Application 08/808,511 commonly owned by the assignee of this application

and incorporated by reference, data sensed by transducer 18 is compared to the comfort standard and an actuation signal is generated which actuates the system to compensate for any differential between the programmed comfort level and the sensor generated data. In order to operate each cell or group of cells independently to provide an extensively adjustable system, the controller 16 is operative to actuate the supply valves 26, 26', 26" to isolate a selected expandable chamber or cell or group of expandable chambers or cells in communication with the manifold. The actuation is controlled in either an open or closed loop fashion to allow the pressure in the chambers 22, 22', 22" to equalize with the pressure in the expandable chamber or cells with which it is communicating. On an instantaneous basis there is a closed system among the connected expandable chambers, the feed tube 28, the common chamber 22, 22', 22" and the fluid supply thereby allowing the sensor to provide data from the closed system and to provide adjustment of the pressure in the isolated expandable chamber(s) by the MPU 21 to the desired comfort or pressure level. In operation, the controller 16 may open a valve 26, 26', 26" interconnecting a selected expandable chamber or cell or expandable chamber or group, such as the back seat region cells 10, with the common chamber 22, 22', 22" and allow the pressure in the selected system to settle out. The time to let pressure equalize is "pressure settling time". After the settling time, the pressure is sensed and a signal is sent to the controller 16 for comparison with the preprogrammed comfort data. The controller 16 then generates a signal relative to the difference in the comfort level sensed to the programmed comfort level and initiates a flow of fluid to or from the selected cell system to reduce the difference to zero. This sequence of operations is then repeated "n" times until each of the expandable chamber or systems are sensed and adjusted.

Alternatively, the controller 16, 16', 16" can be a controller system that will control the time in which fluid volume is transferred during inflate, deflate or equilibration as will be described in massage sequences that are based upon a predetermined massage index. Such timed control is an open loop control and does not depend upon the use of a transducer to sense pressure limits within the expandable chambers during a massage cycle.

The massage indexes of the present invention will be understood to have application to either the embodiment of Figure 2 or the embodiments shown in Figure 6 and in Figure 7 of previously mentioned USSN 8/808,511. The massage indexes also applies to the embodiments of Figures 4 and 5. It should be understood that the operation of the inflate, deflate and if desired equilibrate indexes to be described herein apply equally well to systems in which the expandable chambers or cells can be independently positioned or remain in a predetermined position on a support surface of a vehicle seat or the like without being part of a pressure system for supporting an occupant.

The device and method of this invention is characterized by using a preset inflate, deflate and if desired an equilibration massage index sequence as the programmed massage level and type and allowing the system to adjust the pressure in each expandable chamber to produce a predetermined massage where the level and intensity of a massage can be selected ranging from light to high that can correspond to a lower pressure or a lower frequency at the light setting; a medium pressure or a medium frequency at the medium setting, etc. In addition the operator can adjust the pressure level in accordance with his or her own perceived massage comfort. It is observed that by varying the comparative massage data and the number and location of the expandable chambers the system of this invention allows for a wide variety of massage types and an almost infinite flexibility of adjustment in a package that is simple, light weight, low cost and efficient.

Additionally, in accordance with the present invention, expandable chambers or cells forming the contouring elements of the seat back and bottom can also be located to form a support in a bed structure or other occupant support system. In this case as in the vehicle seat application the expandable chambers have their pressure controlled in response to the selected type of massage index resulting in a sequence of flow to and from each expandable chamber during a predetermined inflate, deflate and if desired equilibrate sequence.

~~As mentioned in the summary of the invention section of this application,~~ IN ~~in~~ the present invention "inflate" is defined as an increase in volume or pressure of fluid (including but not limited to air) in one of one or more expandable

chambers 3a-3b; 4a-4c; 10a-10c. Such increase in volume or pressure is effected by opening supply valves 26, 26', 26" and closing exhaust valves 34, 34', 34" while energizing pump(s) 12, 12', 12" to move volumes of fluid either for a time or until a specified pressure is achieved. In most cases, the pump is connected to a manifold or common chamber 22,22', 22" and a supply valve 26, 26", 26" is connected to each of the expandable chambers to control the flow of fluid the between the common manifold chamber and the other one or more expandable chambers.

"Deflate" in the present invention is defined as decreasing the volume or pressure of fluid (a fluid may include air but is not limited to air as the fluid medium) in each one of the expandable chambers. Such deflation is effected, in configurations shown in Figures 4 and 5, by closing a supply valve 26', 26" to one of the chambers 3', 3", 4', 4" and 10', 10" and opening an exhaust or vent valve 34', 34" to such expandable chambers to move volumes of fluid either for a time or until a particular pressure is achieved. Such deflation is effected, in another configuration shown in Figure 1, by opening a vent valve 34 (controls the flow of fluid from the common chamber to the atmosphere) and the supply valve 26 to the particular chamber (controls the flow of fluid between the common chamber and the other chambers).

Equilibrate is defined in the present invention as an exchange of fluid (including but not limited to air) between two or more of one or more expandable chambers. Such exchange of fluid is effected by closing the vent valve(s) of two or more chambers and opening supply valves to the same two or more chambers for a specified time. The fluid will flow from the higher-pressure chamber(s) to the lower pressure chamber(s) resulting in an equalization of pressure in all of the participating chambers. The resultant pressure will be less than the initial higher pressures and more than the initial lower pressures unless the pressures were equal to start with.

Looking specifically at the occupant support system of Figure 1, a system of M air zones (spaced parallel and full width expandable chambers or cells individually formed as shown at 3 (cells 3a, 3b and 3c), (cells 4a, 4b, 4c) and

10(cells 10a, 10b and 10c), where M is greater than or equal to one, m corresponds to one air zone (3a). For a given massage sequence, each step in the sequence is defined by an index, n, where n ranges from 0 to N-1. N is the total number of steps in the sequence. An air zone, m, maybe associated with more than one index, n, and the adjustment sequence is not constrained by the physical zone order 0 through M-1. The massage sequence is repeated as many times as necessary to complete the timed massage interval.

Let inflation be defined by I (n), deflation by D (n) and equilibration by E (n_0, n_1, ... n_{J-1}) where J ranges from 2 to M. For equilibration, the valves to the zones corresponding to the indexes are opened creating a pneumatic circuit between the zones thus allowing the pressures to equalize within the zones.

There are an infinite number of massage sequences that may be defined by assigning zones to indexes then defining the adjustment order of the indexes. In the simplest case, each index corresponds to a single zone and is defined according to the physical zone orientation. In more complex cases, the zone order assignment to the indexes may be random and one zone may correspond to more than one index.

Inflation and deflation may be based on time or pressure. If based on time, inflation or deflation is performed for a set period of time. The intensity of the massage is controlled by scaling the adjustment time. If based on pressure, the inflation or deflation is performed until a preset target pressure is achieved. In this case, the intensity of the massage is controlled by scaling the target pressure. Equilibration generally is active for a specific time. The sensation of massage speed is controlled by equilibration time or the velocity of the volume of airflow.

Massage sequences that include Indexes 0 through N-1

Sequence 1	**Sequence 2**	**Sequence 3**	**Sequence 4***	
I(N-1)	I(0)	I(N-2)	I(0)	
I(N-2)	D(0)	D(N-2)	E(0,1)	
...	I(1)	Sequence ... continued	D(0)	
I(0)	D(1)	I(0)	I(1)	
D(0)	I(2)	D(0)	E(1,0)	

D(1)	D(2)		D(1)	
D(2)	Sequence ... continued			
Sequence ... continued	I(N-1)			
D(N-1)	D(N-1)			

Sequence 5	Seq. 5 cont.
E(0,1)	D(N-2)
I(0)	E(N-2,N-1)
D(1)	I(N-2)
E(1,0)	D(N-1)
I(1)	E(N-3,N-2)
D(0)	I(N-3)
E(2,1)	D(N-2)
I(2)	...
D(1)	E(1,2)
...	I(1)
E(N-1,N-2)	D(2)
I(N-1)	

*Sequence 4 is shown for a two-zone system. In this case m = n.

Additional massage sequences can be constructed from the sequences shown. For example implementing Sequence 1 followed by Sequence 2 or Sequence 3 followed by Sequence 4 provide two more massage types.

Sequences 1 and 2 are operative to produce groupings of cell to cell pulse and Sequences 3 and 5 are operative to produce an individual cell to cell inflate or deflate wave wherein the massage movement includes a sequence of inflate and deflate between the respective cells so as to provide more concentrated massage while maintaining a wave type movement of the cells producing the massage action. Sequence 4 is operative to produce massage in a two-zone system.

More specifically, Figure 1, omitting the headrest, shows 13 air cells (3a, 3b, 3c, 4a, 4b, 4c, 10a, 10b, 10c, 5, 6, 7 and 8 which are arranged in 11 air zones 3a, 3b, 3c, 4a, 4b, 4c, 10a, 10b, 10c, 5 and 6 combined and 7 and 8 combined. A massage system may have as few as 1 zone and as many zones as the seat and air cell size dictate. To use general terminology, let m correspond to a specific zone

where m ranges from 0 to M-1 and M is the total number of zones. The relation between an air zone and an air cell is that a zone may contain more than one air cell.

For massage in accordance with this invention, any zones may be inflated, deflated and possibly equilibrated in any sequence. A single air zone may be adjusted more than once in any single sequence. There are an infinite number of massage sequences depending on the total number of zones, the number of zones massaged, inflation/deflation/equilibration order in which in/out flow to each zone occurs.

One way to cover the variations is to define the inflation/deflation/equilibration sequence using indexes. Each index is associated with (represents) a single zone but a zone may be associated with more than one index. Indexes, n, range from 0 to N-1, where N is the total number of indexes.

Example: Assume a three zone massage is desired. The zones chosen are 3a, 3b, 3c on Figure 1. Assume the massage sequence contains 4 indexes: 0,1,2,3. The association between the zones and the indexes is chosen to be:

Index	Zone
0	3a
1	3b
2	3a
3	3c

The massage sequence then chosen is Sequence 3, for example.

Step	Action by Index	Action by Zone	Word Description
1	I(0)	I(5)	Inflate zone 3a
2	D(0)	D(5)	Deflate zone 3a
3	I(1)	I(6)	Inflate zone 3b
4	D(1)	D(6)	Deflate zone 3b
5	I(2)	I(5)	Inflate zone 3a
6	D(2)	D(5)	Deflate zone 3a
7	I(3)	I(7)	Inflate zone 3c
8	D(3)	D(7)	Deflate zone 3c
	Repeat	Repeat	

Thus, within the context of systems having expandable chambers that are each inflated and deflated by index selections to produce concentrated massage, there are an infinite number of possible massage sequences. The different massages depend on the number of zones active for massage, the sequences of inflations, deflations and equilibrations and the times or pressure settings (duration) associated with the air movement functions.

The specific sequences provided in the descriptions below are only a small subset of the range of possibilities.

The sequences currently implemented are (by index):

"Pulse"	"Wave"	Massaging	3 Zone
I(0)	E(0,1)	D(0,1,2)	D(0,1,2)
I(1)	I(0)	I(0), D(1,2)	I(0), D(1,2)
I(2)	D(1)	I(1), D(0,2)	I(1), D(0,2)
I(5)	E(1,0)	I(2), D(0,1)	I(2), D(0,1)
I(6)	I(1)	I(1), D(0,2)	Repeat all except
I(7)	D(0)	I(0), D(1,2)	D(0,1,2)
D(7)	E(2,1)	Repeat all except	
D(6)	I(2)	D(0,1,2)	
D(5)	D(1)		
D(2)	E(5,2)		
D(1)	I(5)		
D(0)	D(2)		
Repeat	E(6,5)		
	I(6)		
	D(5)		
	E(7,6)		
	I(7)		
	D(6)		
	E(6,7)		
	I(5)		
	D(6)		
	E(2,5)		
	I(2)		
	D(5)		
	E(1,2)		
	I(1)		
	D(2)		
	Repeat		

In each of these cases the expandable chambers do not carry the reference numeral designations shown in the various embodiments but it is understood that the designations are for a support system having zones 0, 1, 2 (could correspond to 4a, 4b, 4c) and zones 5, 6 and 7 (could correspond to 3a, 3b, 3c).